UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF CHEMICAL SAFETY
AND POLLUTION PREVENTION

January 7, 2021

PC Code: 098301
DP Barcodes: 460216

MEMORANDUM

SUBJECT: **Aldicarb:** Drinking Water Exposure Assessment (DWA) for Proposed New Use on Citrus Grown in Florida

FROM: James Lin, Ph.D., Environmental Engineer
Environmental Risk Branch 2
Environmental Fate and Effects Division (7507P)

THRU: Stephen Wente, Ph.D., Senior Scientist
Karen Milians, Ph.D., Risk Assessment Process Leader
Amy Blankinship, Branch Chief
Environmental Risk Branch 2
Environmental Fate and Effects Division (7507P)

TO: Debra Rate, Senior Regulatory Specialist
Shanta Adeeb, Product Manager (PM10)
Marion Johnson, Branch Chief
Invertebrate & Vertebrate Branch 2
Registration Division (7505P)

William Donovan, Chemist
Mike Metzger, Branch Chief
Risk Assessment Branch 5 and 7
Health Effects Division (7509P)

The Environmental Fate and Effects Division (EFED) has completed its drinking water exposure assessment (DWA) for the proposed new use of a carbamate insecticide aldicarb [AgLogic 15GG, EPA Reg. No. 87895-4 (15% a.i.; PC Code 098301)] on citrus in Florida to control the Asian Citrus Psyllid and other pests. This assessment reflects updated aquatic modeling using the pesticide in water calculator (PWC v1.52). The recommended estimated drinking water concentrations (EDWCs) are presented in **Table 1**. To assist the Health Effects Division (HED) with further refinement of its dietary assessment, a timeseries of the daily average surface water concentrations and ground water concentrations were provided. The EDWCs reported here reflect exposure in drinking water from both surface and ground water. The residues of concern considered in the exposure are: aldicarb parent, aldicarb sulfoxide, and aldicarb sulfone.

Table 1. Maximum Surface and Ground Water Estimates for Proposed Use on Citrus in Florida

Source	**1-in-10 Year Daily Average (µg/L)**	
Surface Water (2-inch incorporation)	5.40	
Surface Water (3-inch incorporation)	2.40	
Source	**Maximum Daily Concentration (µg/L)**	
Ground Water (3-inch incorporation, @pH 6)	No well setback	1000 ft well setback
	160	0.0175

1 Proposed Label Use Information

The proposed use is for oranges and grapefruit in Florida, as a supplemental label to the AgLogic 15 GG label (EPA Reg No. 87895-4). The proposed supplemental label specifies that aldicarb granules will be applied along the dripline of citrus trees in a band of furrows that are at a minimum of 3-inches deep and immediately covered with soil. Granules are applied in 3 to 6 furrows and spaced on approximately 12-inch centers. The width of each band should equal ¼ the tree row spacing. Also, if the trees are furrow irrigated, the granules are applied at least 3 inches deep in irrigation furrow using 2 shanks per furrow.

The label allows only a single application rate of 33 lb/acre (4.95 lb a.i./A) per year. For ground water protection, the proposed restrictions include:
- Do not apply within 500 feet of any drinking water well.
- Do not apply within 1,000 feet of any drinking water well on any soil series identified by the USDA Natural Resources Conservation Service as a highly permeable well-drained soil.

2 Drinking Water Exposure Assessment

The most recent DWA was done in 2015 (USEPA, 2015). The physicochemical properties and environmental fate parameters of aldicarb and two degradates are presented in that assessment (a summary of that information is also presented in **Appendix A** of this document). The residues of concern include aldicarb parent compound and two structurally similar degradates: aldicarb sulfoxide and aldicarb sulfone. Since both degradates exhibit similar fate characteristics and toxicity to that of aldicarb, a Total Residue (TR) approach was used for modeling exposure to all three residues. The chemical input parameters for aldicarb TR are presented in **Table 2** (USEPA, 2006; USEPA, 2015).

Table 2. Chemical Input Parameters for Aldicarb Total Residue

Input Parameter	Value	Justification
K_d (mL/g)	0.16	Mean value for aldicarb, its sulfoxide and its sulfone
Aerobic aquatic metabolism half-life (days) [Temp. (°C)]	12 [25]	Single acceptable guideline study for aldicarb TR (4 days) x 3
Anaerobic aquatic metabolism half-life (days)	24	No data; use 2X aerobic aquatic half-life
Aqueous photolysis half-life (days) [Ref. Latitude (°)]	4 [40]	Represents the single value for the residues of concern
Hydrolysis half-life (days)	0	stable for aldicarb TR @pH 7 (The half-life values for parent aldicarb are 152 days, 63 days, and 6 days, respectively for pH 6, 7 and 8.)
Aerobic soil metabolism half-life (days) [Temp. (°C)]	55 [25]	Represents the upper 90% confidence bound on the mean for combined aldicarb TR half-lives from 19 soils
Foliar half-life (days)	0	Default value in the absence of data
Molecular mass (g/mol)	190.3	Molecular mass of aldicarb
Vapor pressure (torr) (25°C)	6.3×10^{-6}	Study value for aldicarb
Solubility in water (mg/L) (25°C)	6,000	Study value for aldicarb

Modeling Approach

In the previous assessment, surface water source drinking water exposure was estimated using an older version of the PWC called the Surface Water Concentration Calculator (SWCC). However, the Pesticide in Water Calculator is the current EFED aquatic exposure model, therefore this was used to calculate EDWCs (version 1.52 was used). Briefly, the PWC v1.52 contains a graphical user interface that runs the Pesticide Root Zone Model (PRZM version 5, November 15, 2006) and the Variable Volume Water Body Model (VVWM, 3/6/2014). PRZM 5 simulates pesticide fate and transport as a result of leaching, direct spray drift, runoff and erosion from an agricultural field. The VVWM model simulates pesticide loading via runoff, erosion, and spray drift assuming a standard watershed of 172.8 ha that drains into an adjacent standard drinking water index reservoir of 5.26 ha, an average depth of 2.74 m (Jones et al., 2000). Simulations for drinking water use the Index Reservoir scenario in the VVWM, which is a surrogate for a drinking water source drawn from a surface water source (USEPA, 2010). Weather and agricultural practices are simulated for 30 years so that the 1-in-10 year exceedance probability at the site can be estimated. The simulation was generated using 30 years of meteorological data, encompassing the years from 1961 to 1990.

Surface Water

To model the surface runoff/erosion, the FLcitrusSTD scenario file was used to model the citrus use in Florida. Two different soil incorporation depths of 2 inches and 3 inches were considered. The assumed application date is April 25th as the proposed label indicates that applications can be performed from November 15 to April 30. For granule applications, 100% efficiency is assumed with no off-target spray drift (USEPA 2009 and 2013). Based on current EFED guidance, for soil incorporation, the triangle distribution (linearly increasing with depth down to the specified depth) was used to calculate EDWCs. The estimated drinking water concentrations (EDWCs) are presented below in **Table 3** (an example output is presented in **Appendix B**). The focus of the drinking water numbers for the human health dietary assessment is the daily average EDWCs, so that is what is presented.

Table 3. Surface Water Estimated Drinking Water Concentrations (EDWCs)

Soil Depth	1-in-10 year Daily average EDWC (µg/L)
2 inches	38.0
3 inches	16.9

The citrus use label restricts applications to only Florida. Since aldicarb is only registered for use on cotton and peanuts in Florida, regional PCAs (Percent Crop Area factors) can be applied to potentially refine the EDWCs. The regional PCA for FL HUC-2 (cotton + vegetable + orchard) is 14.2% (USEPA 2014).

The final EDWCs from surface water sources using the regional PCA adjustment of 14.2% from Florida are shown below in **Table 4**:

Table 4: Surface Water EDWCs in Florida with PCA Adjustments

Soil Depth	1-in-10 year Daily average EDWC (µg/L)
2 inches	5.40
3 inches	2.40

A timeseries of the daily average surface water concentrations was provided to the Health Effects Division (HED) for further refinement of its dietary assessment.

Ground Water

PWC was also used to estimate the EDWCs from the ground water sources. It incorporates the PRZM-GW (Pesticide Root Zone Model for Ground water) algorithm to estimate exposure in ground water. PRZM-GW is a one-dimensional leaching model used to estimate potential concentrations of pesticides in ground water. The model accounts for pesticide fate in the crop root zone by simulating transport and degradation occurring throughout the soil profile after a pesticide is applied to an agricultural field. PRZM-GW permits the simulation of multiple years of pesticide application (up to 100 years) on a single site.

Since the use is on citrus in Florida, the FL Central Ridge GW scenario was used to calculate ground water EDWCs. The PWC-GW maximum daily EDWCs are presented below based on three different pH values (6, 7 and 8) and two incorporation depths (2 and 3 inches). Since hydrolysis is pH dependent for aldicarb parent compound, ground water EDWCs were calculated for the three different hydrolysis half-lives which were 152 days, 63 days, and 6 days, respectively for pH 6, 7 and 8. Hydrolysis half-life of combined aldicarb residues in groundwater was estimated based on aldicarb sulfone because parent compound only hydrolyzes at pH 9 and aldicarb sulfoxide hydrolyzes rapidly only at pH 9 but only 6% at 30 days on pH 7. Furthermore, aldicarb sulfone is the terminal toxic degradate of parent aldicarb and is of core concern due to its mobility and persistence in subsurface conditions. EPA estimated the hydrolysis half-life at pH 6 using the measured rates at pH values of 5, 7, and 9 (USEPA 2015).

The maximum daily ground water EDWCs are presented below in **Table 5**.

Table 5. Maximum Daily Ground Water EDWCs

Modeled Scenario	Ground Water pH	Maximum Daily Concentration (µg/L)	
		2 inches	3 inches
FL Central Ridge	6	157	160
	7	53.4	54.4
	8	4.42	4.56

It is noted that the proposed label has the following restrictions for use on citrus:

> *In Florida, state regulations Section 5E-2.028 F.A.C., require that AGLOGIC 15GG not be used on Florida citrus within 1000 feet of a drinking water well regardless of depth of water table, when soils (such as those listed below) have a permeability rate greater than 20 inches per hour with an available water capacity less than 0.06 in all layers to a depth of 80 inches as identified by the U.S.D.A. Natural Resources Conservation Service, unless it is known or reasonably believed based on authoritative sources that such wells are either cased to 100 feet below ground level or a minimum of 30 feet below the water table. The U.S.D.A. Natural Resources Conservation Service which serves your county can tell you if the soils in your grove(s) fall within this category.*

Adamsville	*Cassia*	*Orsino*	*Satellite*
Archbold	*Lake*	*Palm*	*St. Lucie*
Astatula	*Neilhurst*	*Beach*	*Travares*
Candler		*Paola*	

It also indicates a 500 ft well set-back for other areas.

Due to the proposed well set-back on the label, EFED calculated EDWCs at different setback distances, and considering the different hydrolysis half-lives at the three different pHs.

Regarding lateral flow velocity, current EFED recommended value is to use a lateral flow velocity of 0.50 ft/day which was used to calculate the final EDWCs with different well setback.

At pH 6, the k value (degradation rate in aquifer) is 0.00456/day based on the hydrolysis half-life of 152 days. The effects of well setback on the maximum daily concentration at different distances are presented in Table 6.

Table 6. Ground Water EDWCs at Various Well Set-back using the pH 6 Hydrolysis Half-life

Well Setback (ft) @ pH 6	Maximum Daily Concentration (µg/L)	
	2 inches depth	**3 inches depth**
0	157	160
100	63.0	64.3
300	10.2	10.4
500	1.64	1.67
1000	0.0171	0.0175

At pH 7, the k value is 0.011/day based on the hydrolysis half-life of 63 days. The effects of well setback on the maximum daily concentration at different distances are presented in Table 7.

Table 7. Ground Water EDWCs at Various Well Set-back using the pH 7 Hydrolysis Half-life

Well Setback (ft) @ pH 7	Maximum Daily Concentration (µg/L)	
	2 inches depth	**3 inches depth**
0	53.4	54.4
100	5.92	6.03
300	0.0726	0.0739
500	0.00089	0.00091
1000	1.48×10^{-8}	1.51×10^{-8}

At pH 8, the k value is 0.1155/day based on the hydrolysis half-life of 6 days. The effects of well setback on the maximum daily concentration at different distances are presented in Table 8.

Table 8. Ground Water EDWCs at Various Well Set-back using the pH 8 Hydrolysis Half-life

Well Setback (ft) @ pH 8	Maximum Daily Concentration (µg/L)	
	2 inches depth	**3 inches depth**
0	4.42	4.56
50	4.25×10^{-5}	4.38×10^{-5}

Similar to surface water, a timeseries of the daily average ground water concentrations was provided to the Health Effects Division (HED) for further refinement of its dietary assessment.

While, historically, aldicarb has been assessed using different hydrolysis rates to calculate ground water EDWCs at pH 6, 7, and 8 (USEPA, 2015), the ultimate recommended EDWCs have relied on the values calculated based on pH 6, which is consistent with the final recommendations in this assessment.

3 Monitoring Data

Monitoring data are useful in that they provide some information on the occurrence of aldicarb residues of concern in the environment under existing usage conditions. However, the measured concentrations should not be interpreted as reflecting the upper end of potential exposures unless they were collected in areas with frequent sampling and where usage was occurring. Absence of detections from non-targeted monitoring cannot be used as a line of evidence to indicate exposure is not likely to occur because it is often collected in areas where the pesticide is not used. Additionally, modeling results are not expected to be similar to monitoring results as monitoring does not reflect the modeled conceptual model and the sampling frequency and duration does not reflect what is simulated in modeling. However, monitoring data is a useful line of evidence to explore whether exposure in the environment is occurring at the levels of the modeled estimated drinking water concentrations (EDWCs). For non-targeted monitoring data, if exceedances are not occuring this is not evidence that exceedances will not occur with usage; however, if there are exceedances, it confirms that exposure occurred in the environment at levels where effects are expected to occur.

Surface Water Monitoring Data

Surface water monitoring data for the aldicarb residues of concern were downloaded from the Water Quality Portal (WQP) ([HYPERLINK "https://www.waterqualitydata.us/"]) in September of 2018. **Figure 3-1** displays WQP monitoring data for aldicarb, aldicarb sulfone, and aldicarb sulfoxide over time (black and red circles) and compares these data to the PWC citrus scenarios (2" and 3" incorporation) EDWCs (lines). The "dissolved" residue concentrations (red circles; from filtered samples) and the "recoverable" and "total" residue concentrations (black circles; from unfiltered samples) are shown in the graph on the date sampled (x-axis) and at the concentration measured (log-scaled y-axis). Samples resulting in non-detections are shown as small light blue x's (dissolved samples) and small light green x's (recoverable/total samples) that occur on the date sampled and reflect the concentration of the detection limit for that sample (i.e., the actual concentration in the sample is only known to be less than the detection limit indicated). Recoverable/total samples are typically older samples. Because they are unfiltered, chemical adsorbed to suspended sediment and therefore potentially not bioavailable may be included in the measured concentration.

In the WQP aldicarb dataset (samples from 1983 - 2018), there were 77 reported detections (0.30%) out of 25,882 surface water samples analyzed (detection limit range = 0.008 to 36.9 µg/L). The maximum aldicarb detection of 2.21 µg/L was from a recoverable sample (1993 collected by the United States Geological Survey in Georgia, USGS). The aldicarb sulfone dataset (samples from 1982 - 2018), there were 53 reported detections (0.20%) out of 26,142 surface water samples analyzed (detection limit range = 0.01 to 15.1 µg/L). The maximum aldicarb sulfone detection of 408 µg/L was from a dissolved sample (2002 collected by the USGS in New York). The aldicarb sulfoxide dataset (samples from 1983 - 2018), there were 111 reported detections (0.42%) out of 26,131 surface water samples analyzed (detection limit range = 0.001 to 22.8 µg/L). The maximum aldicarb sulfoxide detections of 2 µg/L were from dissolved samples collected 28 minutes apart at the same site (1994 collected by the USGS in Missouri).

The detected historical surface water concentrations of all three aldicarb residues appear to decline over time. While the total residue surface water EDWCs are generally higher than the historical monitored concentrations, there is some overlap with the older samples. The highest monitored concentrations from the more recent samples are an order of magnitude below the EDWCs. However, overall, the EDWCs calculated for the proposed use on citrus are within an order of magnitude of what has historically been observed for aldicarb uses.

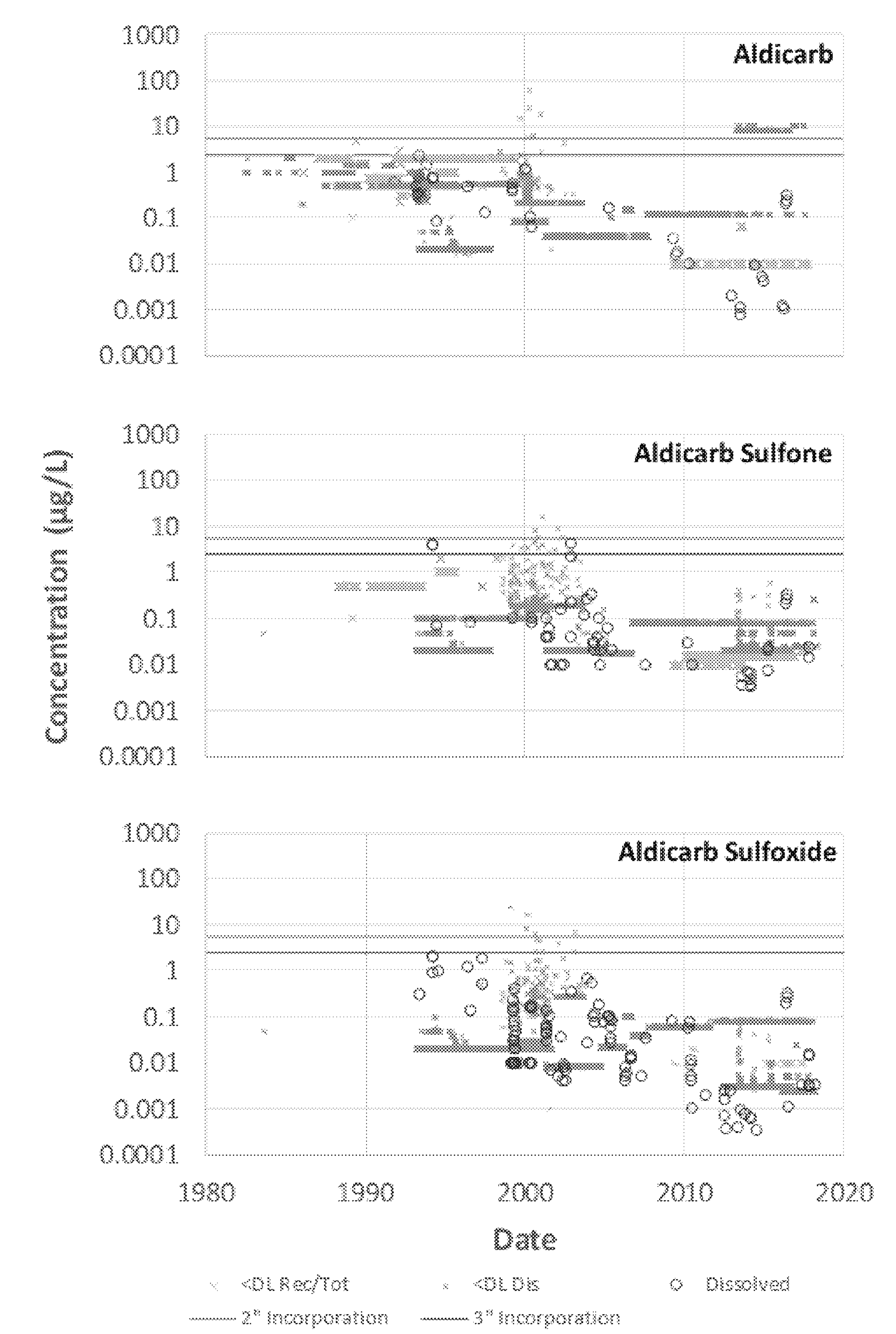

Figure 3-[SEQ Figure * ARABIC]. Comparison of surface water PWC EDWCs and historic surface water monitoring data for the aldicarb residues of concern over time.

Ground Water Monitoring Data

Ground water monitoring data for the aldicarb residues of concern were also downloaded from the Water Quality Portal (WQP) in September of 2018. Similar to surface water, **[REF _Ref57147829 \h * MERGEFORMAT]** displays WQP ground water monitoring data over time (circles) and compares these data to the ground water PWC Florida citrus scenario modeled EDWCs (lines). The key difference with the surface water graphs is the ground water EDWCs vary with pH and well setback. In this first set of ground water graphs, the blue lines (solid and dashed) indicate how the highest EDWCs (pH 6) vary with well setbacks of 0′ (directly beneath the treated crop), 500′, and 1000′ away from the treated crop. The solid red (pH 7) and yellow (pH 8) lines can be compared to the solid blue line (pH 6) to show how pH affects EDWCs at a well setback of 0′.

In the WQP aldicarb ground water dataset (samples from 1981 - 2018), there were 51 reported detections (0.35%) out of 14,674 surface water samples analyzed (detection limit range = 0.008 to 61.3 µg/L). The maximum detection of 180 µg/L was from a recoverable sample (1982 collected by the USGS in New York). The aldicarb sulfone dataset (samples from 1982 - 2018), there were 156 reported detections (0.96%) out of 16,216 ground water samples analyzed (detection limit range = 0.015 to 308 µg/L). The maximum aldicarb sulfone detection of 79 µg/L was from a recoverable sample (1984 collected by the USGS in New York). The aldicarb sulfoxide dataset (samples from 1982 - 2018), there were 189 reported detections (1.2%) out of 16,199 ground water samples analyzed (detection limit range = 0.0025 to 2 µg/L). The maximum aldicarb sulfoxide detection of 85 µg/L was from a recoverable sample (1983 collected by the USGS in New York).

Similar to surface water, the detected historical ground water concentrations of all three aldicarb residues appear to decline over time. While the total residue ground water EDWCs are generally higher than the historical monitored concentrations for the 0′ well setback at pH 6, there is some overlap with the older samples. However, a 0′ well setback at a ground water pH of 6 is likely a relatively rare occurrence within the data set. At both higher pHs and greater well setbacks much lower concentrations are expected.

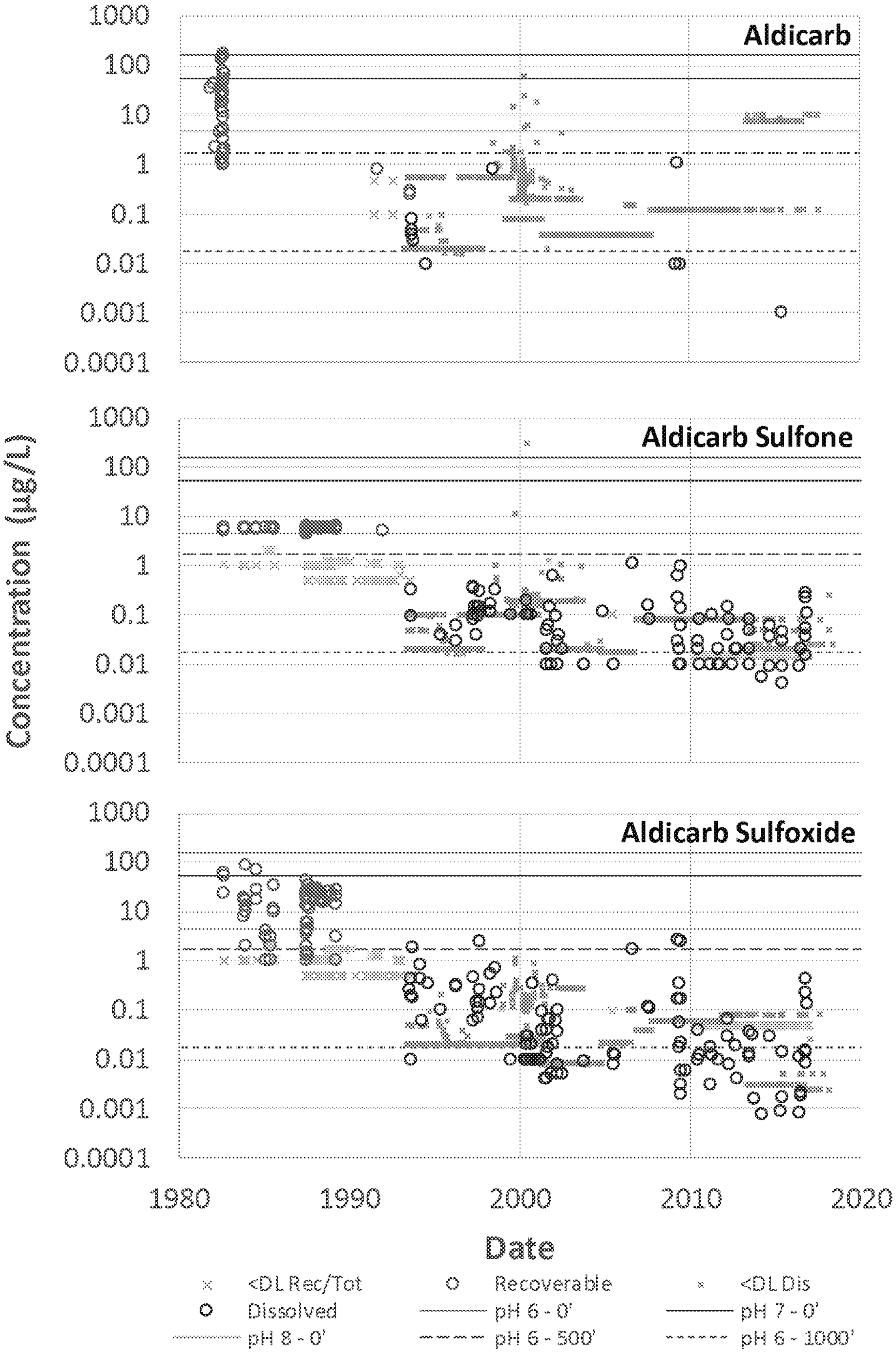

Figure 3-[SEQ Figure * ARABIC]: Comparison of ground water PWC EDWCs and historic ground water monitoring data for the aldicarb residues of concern over time.

To better show the overlap of the ground water EDWCs and historical monitoring the x-axis is changed from time to pH in **[REF _Ref57149998 \h * MERGEFORMAT]**. Switching from time to pH causes the less than values that tended to decrease over time in the two previous figures in a somewhat orderly fashion to smear-out over the full range of pH depicted. This shows that monitoring was conducted over the entire pH range, but the detected values tend to decrease as pH increases and disappear at the highest part of the depicted pH range. In these graphs the change in EDWC with pH can be better depicted with the green dashed line (0' well setback) appearing just above the highest monitored concentrations and the red (500' well setback) and yellow (1000' setback) lines occuring within the monitored concentrations at pH 6 and rapidly dropping below any detected monitoring data at higher pH. The anticipated ground water EDWCs from the new uses are consistent with what has historically been observed in ground water for other aldicarb uses.

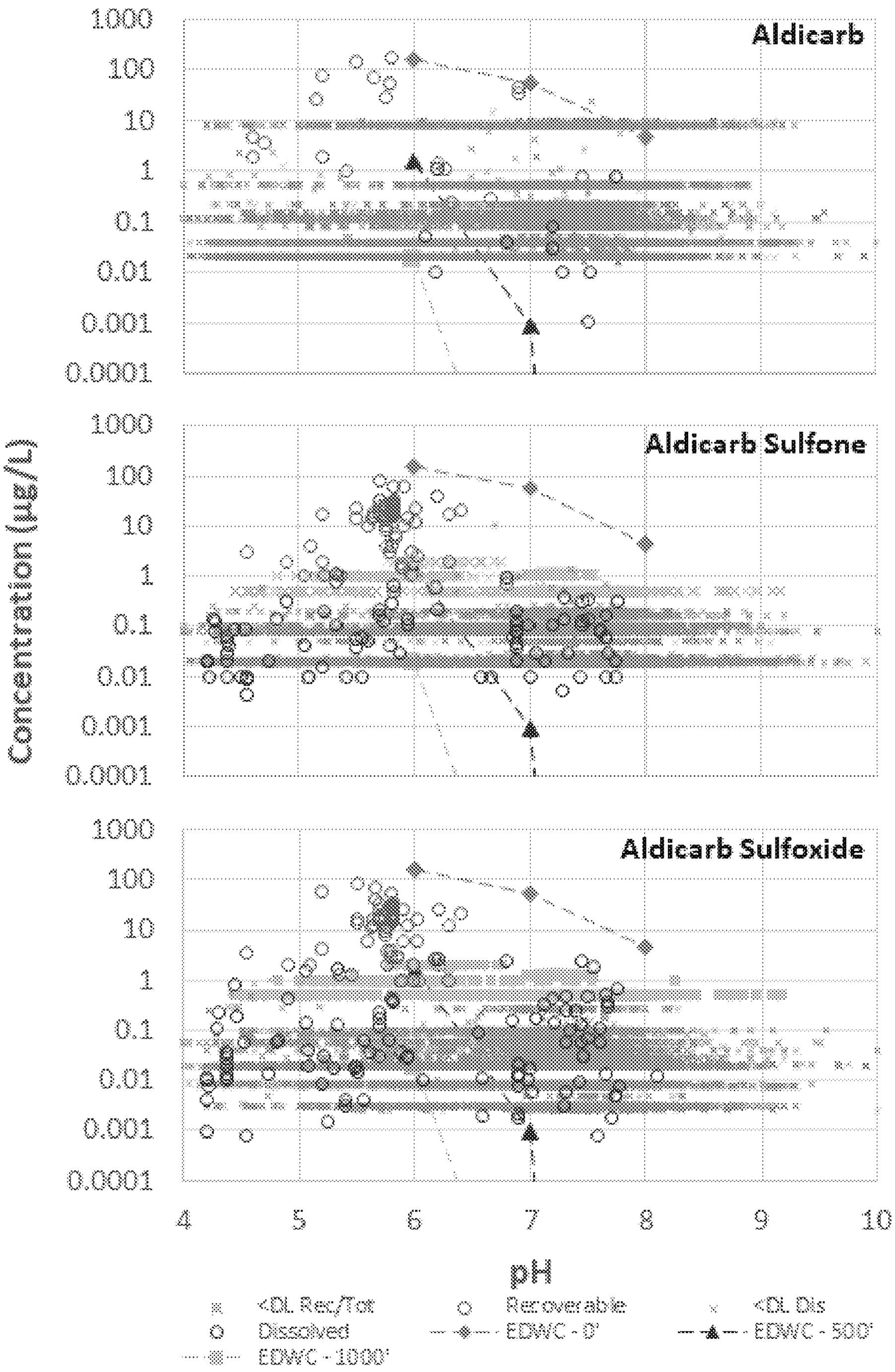

Figure 3-[SEQ Figure * ARABIC]: Comparison of ground water PWC EDWCs and historic ground water monitoring data for the aldicarb residues of concern across a pH range.

4 Drinking Water Treatment

The Office of Pesticide Programs (OPP) obtained data on the effects of drinking water treatment on aldicarb from a search (11/24/2020) in the U.S. EPA Drinking Water Treatability

Database ([HYPERLINK "https://oaspub.epa.gov/tdb/pages/general/home.do"]). According to this source, the following processes are effective for the removal of aldicarb: reverse osmosis membrane (equal or greater than 98 percent removal), granular activated carbon (97 percent removal) and ultraviolet irradiation with ozone (83 percent removal). Performance of these technologies can vary based on dose, contact time and water quality characteristics. However, there were no information given for aldicarb sulfone and aldicarb sulfoxide.

5 Conclusions

The recommended EDWCs are presented in the table below. The EDWCs reported here reflect exposure in drinking water from all the residues of concern: aldicarb parent, aldicarb sulfoxide, and aldicarb sulfone. These EDWCs are refined values and include regional PCT for surface water and well setbacks for ground water.

Table 6. Maximum Surface and Ground Water Estimates for Proposed Use on Citrus in Florida

Source	**1-in-10 Year Daily Average (µg/L)**	
Surface Water (2-inch incorporation)	5.40	
Surface Water (3-inch incorporation)	2.40	
	Peak Daily Concentration (µg/L)	
Ground Water (3-inch incorporation, @pH 6)	No well setback	1000 ft well setback
	160	0.0175

REFERENCES

USEPA. 2006. Drinking Water Exposure Assessment for Total Aldicarb Residues (Parent, Aldicarb Sulfoxide, and Aldicarb Sulfone) Based on the N-Methyl Carbamate Cumulative Risk Assessment; DP 333309.

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U.S. EPA. 2010. Guidance on Development and Use of the Index Reservoir in Drinking Water Exposure Assessments. U.S. Environmental Protection Agency, Office of Pesticide Programs, Environmental Fate and Effects Division. Arlington, VA.

USEPA. 2013. Guidance on Modeling Offsite Deposition of Pesticide Via Spray Drift for Ecological and Drinking Water Assessments. U.S. Environmental Protection Agency, Office of Pesticide Programs, Environmental Fate and Effects Division. Arlington, VA. USEPA. 2009. Guidance for Selecting Input Parameters in Modeling the Environmental Fate and Transport of Pesticides. Version 2.1 October 22, 2009. U.S. Environmental Protection Agency, Office of Pesticide Programs, Environmental Fate and Effects Division. Arlington, VA.

USEPA. 2014. Development of Community Water System Drinking Water Intake Percent Cropped Area Adjustment factors for use in Drinking Water Exposure Assessments. U.S. Environmental Protection Agency, Office of Pesticide Programs, Environmental Fate and Effects Division.

Arlington, VA. [HYPERLINK "https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/development-community-water-system-drinking-water"]

USEPA. 2015. Aldicarb: Drinking Water Exposure Assessment for Preliminary Risk Assessment Environmental Fate and Effects Division. Office of Pesticide Programs. DP 427697.

Appendix A – Physio-chemistry and Fate Properties of Aldicarb (excerpt from USEPA 2015)

Aldicarb degrades to aldicarb sulfone and aldicarb sulfoxide, primarily by aerobic soil metabolism (parent half-lives range from 1 to 28 days in a variety of soils). Aerobic soil metabolism half-lives for the combined residues (i.e., aldicarb, sulfoxide, sulfone) range from 11 to 136 days, with a 90th percentile upper bound on the mean of 55 days. This is within the range observed in published field studies, where dissipation half-lives for total toxic residues ranged from approximately 0.3 to 5 months in the unsaturated zone, and 1 to 36 months in the saturated zone (Jones and Estes, 1995).

Aldicarb is relatively stable to hydrolysis, slowly hydrolyzing only at a pH of 9 (MRID 00102065). Aldicarb sulfoxide hydrolyzed more quickly ($t_{1/2}$ = 2 - 3 days) at pH 9 than at pH 7 (about 6% at 28 days) (MRID 00102066). Aqueous photolysis rapidly degraded aldicarb to oxime and nitrile forms (*i.e.* with a $t_{1/2}$ of 4 days: MRID 42498201). However, this process will only be dominant in clear, shallow waters, and will not affect residues in the subsurface.

Aldicarb and its degradates are highly mobile in soil. Freundlich K_{ads} values ranged from 0.20 to 0.60 mL/g for aldicarb (MRID 42498202), 0.17 to 0.36 mL/g for aldicarb sulfoxide (MRID 43560301), and 0.12 to 0.22 mL/g for aldicarb sulfone (MRID 43560302).

The lines of evidence from available registrant-submitted studies, published literature, and monitoring data indicate that the total toxic residues of aldicarb will degrade slowly in upper soil layer, move fairly rapidly into the subsurface (the rate of movement depending upon the permeability of the soil and amount of excess water that moves through the soil), and potentially persist in the subsurface and ground water under acidic (pH<7) conditions. The sulfoxide and sulfone degradates will hydrolyze rapidly in alkaline soils, so the ultimate fate in ground water will depend upon the pH of the soil, vadose zone, and aquifer.

Table A-1 include the environmental fate data for aldicarb (parent only) and total residues while **Table A-2** lists the environmental fate data of aldicarb sulfoxide and aldicarb sulfone.

Table A-1. Chemical Properties and Environmental Fate Parameters of Aldicarb

Parameter	Value	Reference
Physical/Chemical Parameters		
Molecular mass	190.26 g/mol	Calculated
Vapor pressure (23°C)	6.25×10^{-6} torr	MRID 4822504
Henry's Law constant (23°C)	3.0×10^{-10} atm·m^3/mol	Calculated
Water solubility (pH 7, 25°C)	6,000 mg/L	MRID 4822504
Octanol-water partition coefficient (K_{OW})	11.48	MRID 4822504

Parameter	Value	Reference
Persistence in Water		
Hydrolysis half-life	pH 5: no significant degradation @ 30 d pH 7: no significant degradation @ 30 d pH 9: < 10% degradation of parent @ 30 d $T_{1/2}$ < 197 d	MRID 00102065
Aqueous photolysis half-life	4 d	MRID 42498201
Persistence in Soil		
Aerobic soil metabolism half-life [25°C]	*parent only*: NJ sandy loam: 2.3 d Houston clay: 11 d Lakeland sandy loam: 17 d Norwood silty clay: 12 d unspecified: 1 d Illinois silt: 6 d NC loamy sand: 10 d *total toxic residues:* Houston clay: 28 d Lakeland sandy loam: 47 d Norwood silty clay: 136 d unspecified: 44 d	 MRID 44005001 MRID 00093642 MRID 45602904 MRID 45739801 MRID 00093642 MRID 45602904
Mobility		
Fruendlich Adsorption Coefficients (K_f)	*parent* sandy loam: 0.186 $L \cdot kg^{-1}$ silt: 0.36 $L \cdot kg^{-1}$ clay: 0.6 $L \cdot kg^{-1}$ sand: 0.2 $L \cdot kg^{-1}$	MRID 42498202 MRID 43560301 MRID 43560302

Table A-2. Environmental Fate Parameters for Aldicarb Sulfoxide and Aldicarb Sulfone

Fate Endpoint	Aldicarb sulfoxide	Aldicarb sulfone
Hydrolysis – pH 5		495 d (MRID 45592104)
Hydrolysis – pH 7	6% loss at 30 d (MRID 00102066)	63 d (MRID 45592104)
Hydrolysis – pH 9	2.3 d (MRID 00102066)	1 da @ 25°C; 32 d @ 5°C (MRID 45592104)
Hydrolysis in published literature: Lemley & Zhong, 1983 (45602901); Hansen & Spiegel, 1983 (45602902);	Hydrolysis is sensitive to hydroxide concentration (base-catalyzed), with sulfone most sensitive and aldicarb least (Lemley & Zhong, 1983).	

Lemley & Zhong, 1984 (45602903)	Aldicarb hydrolysis rates increase at pH levels >7.5; sulfoxide and sulfone hydrolyze more readily and are affected by pH and temperature (results for 5, 15 °C) (Hansen & Spiegel, 1983). Both pH and temperature dependence seen in hydrolysis of all 3 chemicals. Rates for sulfone at 25 °C 60 d @ pH7, 6 d @ pH8 (Lemley & Zhong, 1984)	
Aqueous photolysis		123 d (12 hr light/dark) (MRID 45592105)
Aerobic soil metabolism (MRID 44005001)	Concentrations fluctuated between 9-86% of applied from 7-60 day post treatment	Concentrations fluctuated between 3-80% of applied from 7-60 day post treatment
Aerobic soil metabolism range (MRID 00101934)	Total carbamate residues (parent, sulfoxide, sulfone) 11 – 110 d in 2 soils x 3 pH x 2 moisture contents; avg 34 d; 90% upper confidence bound 48 d	
Aerobic soil metabolism	5 d (MRID 45592108)	3.33 d half-life (pH 6.7 soil) (MRID 00053370)
	Total carbamate residues (parent, sulfoxide, sulfone) 28, 47, 136 for 3 soils (MRIDs 00093642, 00080820, 00093640, 00053366)	
Lab studies of all 3 forms (Lightfoot *et al*, 1987; Bank & Tyrrell, 1984) [A]	Combined residues (aldicarb, sulfoxide, sulfone) degraded to oximes, nitrile with half-lives up to 3 months; soil-catalyzed hydrolysis, not aerobic metabolism was driving factor.	
Lightfoot *et al*, 1987 (MRID 45602904)	Combined (parent+degradate): 44 (unsterilized) – 10 (sterilized) d surface soil 123 (unsterilized) – 16 (sterilized) d subsurface soil	
Aerobic soil metabolism, 2002 registrant submissions (MRID 45739802)		15.2 d in IL silt (pH 7.9); 91.2 d in NC loamy sand (pH 6.2).
Aerobic soil metabolism literature (Smelt et al, 1983)	sulfone & sulfoxide half-lives in Dutch subsoils from 2-131 d under anaerobic cond., 84-1100 d under aerobic condition	

Aerobic aquatic metabolism, 2002-3 registrant submissions	5 d (total system) in pH 7.0 water / pH 6.3 sediment (MRID 45592108)	3.5 d (total system) in pH 7.0 water / pH 6.3 sediment (MRID 45592109)
Anaerobic aquatic metabolism	3.4 d (MRID 45592110)	3.5 d (MRID 45592111)
Published field studies (Jones & Estes, 1995)	Summarized results of 32 field studies for aldicarb in 24 locations. Half-life of total carbamate residues (aldicarb, sulfoxide, sulfone) in surface soil ranged from 0.3 to 3.5 months; mean 1.3 mo (40 d) & 90% upper confidence bound on mean 1.5 mo (45 d). In 2 studies, estimated subsurface half-life of 5 months.	
Fruendlich Adsorption Coefficients (K_f) (MRID 42498202, 43560301, 43560302)	*aldicarb sulfoxide* ($L \cdot kg^{-1}$): Tujunga loamy sand: 0.22 Wedowee sandy loam: 0.17 Huntington silt loam: 0.26 Huntington sandy clay loam: 0.26	*aldicarb sulfone* ($L \cdot kg^{-1}$): Tujunga loamy sand: 0.09 Wedowee sandy loam: 0.12 Huntington silt loam: 0.22 Huntington sandy clay loam: 0.22

[A] Study looks at degradation of aldicarb and total carbamates (parent, sulfoxide & sulfone) in surface soil, soil water, distilled water, saturated zone soil in sterilized/unsterilized conditions

Appendix B – Summary of Water Modeling of Aldicarb and the USEPA Standard Reservoir for FLcitus

Estimated Environmental Concentrations for Aldicarb TTR are presented in Table 1 for the USEPA standard reservoir with the FLcitrusSTD field scenario with the 2 inch incorporation. A graphical presentation of the year-to-year peaks is presented in Figure 1. These values were generated with the Pesticide Water Calculator (PWC), Version 1.52. Critical input values for the model are summarized in Tables 2 and 3.

This model estimates that about 0.16% of Aldicarb TTR applied to the field eventually reaches the water body. The main mechanism of transport from the field to the water body is by runoff (100% of the total transport).

In the water body, pesticide dissipates with an effective water column half-life of 10.1 days. (This value does not include dissipation by transport to the benthic region; it includes only processes that result in removal of pesticide from the complete system.) The main source of dissipation in the water column is metabolism (effective average half-life = 12.9 days) followed by washout (51.4 days) and photolysis (466.1 days).

In the benthic region, pesticide dissipates (25.8 days). The main source of dissipation in the benthic region is metabolism (effective average half-life = 25.8 days). Most of the pesticide in the benthic region (about 70%) is in the pore water rather than sorbed to sediment.

Table 1. Estimated Environmental Concentrations (ppb) for Aldicarb TTR.

Peak (1-in-10 yr)	39.2
4-day Avg (1-in-10 yr)	34.6
21-day Avg (1-in-10 yr)	21.3
60-day Avg (1-in-10 yr)	9.49
365-day Avg (1-in-10 yr)	1.58
Entire Simulation Mean	0.429

Table 2. Summary of Model Inputs for Aldicarb TTR.

Scenario	FLcitrusSTD
Cropped Area Fraction	1.0
Kd (ml/g)	0.16
Water Half-Life (days) @ 25 °C	12
Benthic Half-Life (days) @ 25 °C	24
Photolysis Half-Life (days) @ 40 °Lat	4

Hydrolysis Half-Life (days)	0
Soil Half-Life (days) @ 25 °C	55
Foliar Half-Life (days)	0
Molecular Weight	190.3
Vapor Pressure (torr)	6.3e-6
Solubility (mg/l)	6000
Henry's Constant	0.0

Table 3. Application Schedule for Aldicarb TTR.

Date (Mon/Day)	Type	Amount (kg/ha)	Eff.	Drift
4/25	Linearly increasing to 5.08 cm	5.544	1	0

Figure 1. Yearly Peak Concentrations